Injection Well Evaluation

Created by EPA R6 Land Ban Oct 2004

This sheet calculates the pressure at the base of the USDW, tubing friction loss, fracture pressure, allowable pressure increase at the injector, cone of influence, and maximum pressure rise at various observation points for the designated years of injection. The injector is centered at (0',0'). This spreadsheet also calculates injection pressure increase at several observation points around the injector for 3 different injection timeframes. Note: friction loss is calculated with Hazen Williams correlation using roughness factor for steel pipe; dimensionless variables were calculated with equations from SPE Monograph 5, Appendix C; and mud filled abondoned wellbores are assumed to have a 20#/100 ft^2 gel strength and 50 ft fallback.

Calculation cell	User input cell

bpd:	330	gpm:	9.6

mud wt	824.78

Input Parameters	
Facility:	OS 5667
Pi (current static resv. pressure in psia): dated 1993	800
h (ft) (net thickness):	450
porosity (fraction): -Arbuckle	0.1
rinj (ft) (wellbore radius of injector):	0.3
ct (1/psi) (total compressibility=rock+fluid):	1.00E-06
viscosity (cp):	0.8
Depth to USDW base (ft):	160
Depth to groundwater (ft):	30
Reservoir fluid SG:	1.066
Min. aband. well diameter (in.)	9
Min. aband. well mud wt. (lb/gal):	9
Top of injection interval (ft):	1813
Permeability (md):	20
Transmissibility (md-ft/cp) (k*h/viscosity):	11250

Injection Well Calculations	
Injection Permit Life (yrs):	10
Injection Permit Life (hrs):	87600
Proposed Injection Rate (gpm):	9.6
Proposed Injection Rate (bpd):	330.0
Tubing size (in.)	2.375
Assumed Fracture Gradient (psi/ft)	0.75
Opposing Pressure at USDW Base (psi):	56.29
Allowable Pressure Rise in Brine Filled Well (psi):	19.28
Allowable Pressure Rise in Mud Filled Well (psi):	38.20
Pressure rise allowed by mud gel strength (psi):	13.42
Abandoned Well Condition (brine or mud)	brine
Fluid column w/ injection tubing fluid filled (psi):	836.840914
Tubing Friction Loss at Proposed Inj. Rate (psi):	2.0
Estimated Fracture Pressure	1359.75
Allowable Pressure Increase at Injector (psi):	520.9
Estimated Permit End Press. Incr. at Injector (psi):	53.2
Critical Pressure for Cone of Influence (psi):	19.28
Cone of Influence at Permit End (ft):	1083.99843

transmissibility = kh/viscosity

Critical Pressure

"brine": head fresh water + head between base USDW & top injection zone - initial formation pressure

"mud": mud gravity * 0.433 *(top injection zone - 50' fall back) + gel strength - initial formation pressure

Gel Strength = ((0.00333*20*TopInj)/Well_diam)

Dimensionless Time, td = 0.0002637*k*t / (porosity)(viscosity)(ct)(rinj^2)

Dimensionless Pressure, pd = Critical pressure*transmissibility / 141.2*rate

Dimensionless Radius, rd = sqrt[td/exp((pd*2)-.80907)]

Dimensionless Radius, rd = r / rinj Radius of ZEI (Cone of Influence at permit end) = wellbore radius * dimensionless radius

Dimensionless Time:	6.42E+10
Dimensionless Pressure:	4.655
Dimensionless Radius:	3613.3

X & Y location of observation pts - distance from injection well located at (0,0)

X	Y	Radial distance from well, r (feet)	rd=r/rinj	time 1 (yrs)	(td/rd^2)1	Press. Rise (psi)	time 2 (yrs)	(td/rd^2)2	Press. Rise (psi)	time 3 (yrs)	(td/rd^2)3	Press. Rise (psi)	
0	0	0.3	1	1	6.42E+09	48.4	5	3.21E+10	51.8	10	6.42E+10	53.2	injector
100	0	100.0	333.3333	1	5.78E+04	24.4	5	2.89E+05	27.7	10	5.78E+05	29.1	
500	0	500.0	1666.667	1	2.31E+03	17.7	5	1.16E+04	21.0	10	2.31E+04	22.5	
1320	0	1320.0	4400	1	3.31E+02	13.7	5	1.66E+03	17.0	10	3.31E+03	18.5	
2640	0	2640.0	8800	1	8.29E+01	10.8	5	4.14E+02	14.2	10	8.29E+02	15.6	
5280	0	5280.0	17600	1	2.07E+01	8.0	5	1.04E+02	11.3	10	2.07E+02	12.7	
8000	0	8000.0	26666.67	1	9.02E+00	6.2	5	4.51E+01	9.6	10	9.02E+01	11.0	
0	500	500.0	1666.667	1	2.31E+03	17.7	5	1.16E+04	21.0	10	2.31E+04	22.5	
0	1320	1320.0	4400	1	3.31E+02	13.7	5	1.66E+03	17.0	10	3.31E+03	18.5	
0	2640	2640.0	8800	1	8.29E+01	10.8	5	4.14E+02	14.2	10	8.29E+02	15.6	
0	5280	5280.0	17600	1	2.07E+01	8.0	5	1.04E+02	11.3	10	2.07E+02	12.7	
0	8000	8000.0	26666.67	1	9.02E+00	6.2	5	4.51E+01	9.6	10	9.02E+01	11.0	
-500	0	500.0	1666.667	1	2.31E+03	17.7	5	1.16E+04	21.0	10	2.31E+04	22.5	
-1320	0	1320.0	4400	1	3.31E+02	13.7	5	1.66E+03	17.0	10	3.31E+03	18.5	
-2640	0	2640.0	8800	1	8.29E+01	10.8	5	4.14E+02	14.2	10	8.29E+02	15.6	
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0	-8000	8000.0	26666.67	1	9.02E+00	6.2	5	4.51E+01	9.6	10	9.02E+01	11.0	
1000	1000	1414.2	4714.045	1	2.89E+02	13.4	5	1.44E+03	16.7	10	2.89E+03	18.2	
2000	2000	2828.4	9428.09	1	7.22E+01	10.5	5	3.61E+02	13.9	10	7.22E+02	15.3	
3000	3000	4242.6	14142.14	1	3.21E+01	8.9	5	1.60E+02	12.2	10	3.21E+02	13.6	
4000	4000	5656.9	18856.18	1	1.80E+01	7.7	5	9.02E+01	11.0	10	1.80E+02	12.4	
X	Y	Radial distance from well, r (feet)	rd=r/rinj	time 1 (yrs)	(td/rd^2)1	Press. Rise (psi)	time 2 (yrs)	(td/rd^2)2	Press. Rise (psi)	time 3 (yrs)	(td/rd^2)3	Press. Rise (psi)	
5000	5000	7071.1	23570.23	1	1.16E+01	6.7	5	5.78E+01	10.1	10	1.16E+02	11.5	
-1000	1000	1414.2	4714.045	1	2.89E+02	13.4	5	1.44E+03	16.7	10	2.89E+03	18.2	
-2000	2000	2828.4	9428.09	1	7.22E+01	10.5	5	3.61E+02	13.9	10	7.22E+02	15.3	
-3000	3000	4242.6	14142.14	1	3.21E+01	8.9	5	1.60E+02	12.2	10	3.21E+02	13.6	
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-1000	-1000	1414.2	4714.045	1	2.89E+02	13.4	5	1.44E+03	16.7	10	2.89E+03	18.2	
-2000	-2000	2828.4	9428.09	1	7.22E+01	10.5	5	3.61E+02	13.9	10	7.22E+02	15.3	
-3000	-3000	4242.6	14142.14	1	3.21E+01	8.9	5	1.60E+02	12.2	10	3.21E+02	13.6	
-4000	-4000	5656.9	18856.18	1	1.80E+01	7.7	5	9.02E+01	11.0	10	1.80E+02	12.4	
-5000	-5000	7071.1	23570.23	1	1.16E+01	6.7	5	5.78E+01	10.1	10	1.16E+02	11.5	